Stoller
Grand Junction Office established 1959

299-W22-75 (A7879)
Log Data Report

Borehole Information:

Borehole:	299-W22-75 (A7879)		Site:	216-U-12 Crib	
Coordinates (WA State Plane)		GWL (ft)[1]:	Not reached	GWL Date:	5/22/03
North	East	Drill Date	TOC[2] Elevation	Total Depth (ft)	Type
134,490.42 m	567,595.19 m	April 1982	211.586 m	176.25	Cable tool

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	1.25	6 11/16	6	0.344	+1.25	169
Threaded Steel	0.5	8 5/8	Unknown	Unknown	+0.5	60
The logging engineer measured the casing stickup using a steel tape. A caliper was used to determine the outside casing diameter. The caliper and inside casing diameter were measured using a steel tape, and measurements were rounded to the nearest 1/16 in. Casing thickness was calculated.						

Borehole Notes:

Borehole coordinates, elevation, and well construction information, as shown in the above tables, are from measurements by Stoller and Duratek field personnel, Ledgerwood (1993), and HWIS[3]. Zero reference is the top of the 6-in. casing. Grout is not present at the surface in the annulus between the casings but is observed on the ground surface surrounding the 8-in. casing.

Logging Equipment Information:

Logging System:	Gamma 2E		Type:	70% HPGe (34TP40587A)
Calibration Date:	03/2003	Calibration Reference:	GJO-2003-430-TAC	
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0	

Logging System:	Gamma 1C		Type:	High Rate Detector (39A314)
Calibration Date:	04/2003	Calibration Reference:	GJO-2003-429-TAC	
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4/ Repeat	
Date	5/22/03	5/22/03	5/27/03	5/27/03	
Logging Engineer	Spatz	Spatz	Spatz	Spatz	
Start Depth (ft)	176.0	59.0	44.0	82.0	
Finish Depth (ft)	58.0	43.0	2.0	64.0	
Count Time (sec)	100	200	200	100	
Live/Real	R	R	R	R	

Log Run	1	2	3	4/ Repeat	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
ft/min	N/A[4]	N/A	N/A	N/A	
Pre-Verification	BE031CAB	BE031CAB	BE032CAB	BE032CAB	
Start File	BE031000	BE031119	BE032000	BE032043	
Finish File	BE031118	BE031135	BE032042	BE032061	
Post-Verification	BE031CAA	BE031CAA	BE032CAA	BE032CAA	
Depth Return Error (in.)	N/A	0	0	0	
Comments	Fine gain adjustments made after files: -012, -023, -077, and -118.	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.	

High Rate Logging System (HRLS) Log Run Information:

Log Run	1	2/Repeat			
Date	6/03/03	6/03/03			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	27.0	26.0			
Finish Depth (ft)	20.0	24.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A	N/A			
Pre-Verification	AC071CAB	AC071CAB			
Start File	AC072000	AC072008			
Finish File	AC072007	AC072010			
Post-Verification	AC072CAA	AC072CAA			
Depth Return Error (in.)	N/A	0			
Comments	No fine-gain adjustment.	No fine-gain adjustment.			

Logging Operation Notes:

Zero reference was top of the 6-in. casing. Logging was performed with a centralizer installed on the sonde. Pre- and post-survey verification measurements for the SGLS were acquired with the Amersham KUT (^{40}K, ^{238}U, and ^{232}Th) verifier with serial number 118. HRLS data were collected using Gamma 1C. Pre- and post-survey verification measurements for the HRLS were acquired with the ^{137}Cs verifier with serial number 1013.

Analysis Notes:

Analyst:	Sobczyk	Date:	6/5/03	Reference:	GJO-HGLP 1.6.3, Rev. 0

SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day. All of the verification spectra were within the control limits except for pre-run verification spectrum BE031CAB. BE031CAB was below the lower control limit for the 609-keV, 1461-keV, and 2615-keV full-width at half-maximum values. The peak counts per second (cps) at the 609-keV, 1461-keV, and 2615-keV photopeaks on the post-run verification spectra as compared to the pre-run verification spectra for each day were between 0.3 and 2.4 percent lower at the end of the day. Examinations of spectra indicate that the detector appears to have functioned normally during logging, and the spectra are accepted.

HRLS pre-run and post-run verification spectra were collected at the beginning and end of the day. The spectra were within the acceptance criteria for the field verification of the Gamma 1C logging system (HRLS).

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Post-run verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source files: G2EMar03.xls and G1CApr03). Zero reference was the top of the 6-in. casing. On the basis of Ledgerwood (1993), the casing configuration was assumed to be a string of 8-in. casing with a thickness of 0.322 in. to 60 ft, a string of 6-in. casing with a thickness of 0.344 in. to 168 ft, and open-hole below 168 ft. The 8-in. casing thickness of 0.322 in. is the published value for ASTM schedule-40 steel pipe (a commonly used casing material at Hanford). Where more than one casing exists at a depth, the casing correction is additive (e.g., the correction for both the 8-in. and 6-in. casing would be 0.322 in. + 0.344 in. = 0.666 in.). A water correction was not needed or applied to the data.

Using the SGLS, dead time greater than 40 percent was encountered in the interval from 21 to 26 ft, and data from this region were considered unreliable. At SGLS dead time greater than 40 percent, peak spreading and pulse pile-up effects may result in underestimation of activities. This effect is not entirely corrected by the dead time correction, and the extent of error increases with increasing dead time. SGLS dead time corrections were applied when dead time surpassed 10 percent. The HRLS was utilized to obtain data where the SGLS dead time exceeded 40 percent.

Log Plot Notes:

Separate log plots are provided for gross gamma and dead time, naturally occurring radionuclides (^{40}K, ^{238}U, and ^{232}Th), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. In addition, a comparison log plot of man-made radionuclides is provided to compare the data collected by Westinghouse Hanford Company's Radionuclide Logging System (RLS) with SGLS data. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations on the combination plot rather than the ^{214}Bi peak at 609 keV because it is less affected by the presence of radon in the borehole.

Results and Interpretations:

^{137}Cs, ^{235}U (based on the 186-keV photopeak), and ^{238}U (based on the 1001-keV photopeak) were the man-made radionuclides detected in this borehole. ^{137}Cs was detected in the interval from 17 to 61 ft with concentrations ranging from 0.3 to 8,400 pCi/g. The maximum concentration of ^{137}Cs was measured at 25 ft. ^{137}Cs was detected at a depth of 12 ft with a concentration near the MDL (0.2 pCi/g). ^{238}U was detected in the intervals from 17 to 20 ft, 29 to 31 ft, 37 to 53 ft, and 61 to 81 ft with an MDL of at least 10 pCi/g. In the interval from 17 to 20 ft, ^{238}U was detected with concentrations ranging from 55 to 330 pCi/g. In the interval from 29 to 31 ft, ^{238}U was detected with concentrations ranging from 20 to 30 pCi/g. In the interval from 37 to 53 ft, ^{238}U was detected with concentrations ranging from 17 to 75 pCi/g. ^{238}U was detected in the interval from 61 to 81 ft with concentrations ranging from 17 to 335 pCi/g. The maximum concentration of ^{238}U was measured at 76 ft, although the highest concentration may be in the interval of high dead time where the MDL significantly increases. ^{235}U was detected in the intervals from 18 to 19 ft, 68 to 81 ft, and at 44 ft with an MDL of at least 1.5 pCi/g. ^{235}U concentrations ranged from 6 to 9 pCi/g at 18 and 19 ft. In the interval from 68 through 81 ft, ^{235}U concentrations ranged from 1.8 to 22 pCi/g. ^{235}U was detected at a depth of 44 ft with a concentration of 5 pCi/g. It is probable that ^{235}U exists in the same intervals as the ^{238}U (based on the 1001-keV photopeak), but the ^{235}U concentration falls below its respective MDL.

The behavior of the naturally occurring ^{238}U log (measured by ^{214}Bi) suggests that radon may be present inside the borehole casing. Determination of ^{238}U is based on measurement of gamma activity at 609 and/or 1764 keV associated with ^{214}Bi, under the assumption of secular equilibrium in the decay chain. However, ^{214}Bi is also a short-term daughter of ^{222}Rn. When radon is present, ^{214}Bi will tend to “plate” onto the casing wall and will quickly reach equilibrium with ^{222}Rn. Because the additional ^{214}Bi resulting from radon is on the inside of the casing, the effect of the casing correction is to amplify the 609 photopeak relative to the 1764 photopeak. (The magnitude of the casing correction factor decreases with increasing energy, but gamma rays originating inside the casing are not attenuated.) The reason for variations in radon content between log runs on successive days is not known. Variations in radon content in boreholes are probably related to variations in surface weather conditions. Radon daughters such as ^{214}Bi may also “plate” onto the sonde itself. When this occurs, there is a gradual increase in total counts as well as photopeak counts associated with ^{214}Bi and ^{214}Pb. This phenomenon appears to best explain the observed discrepancy in ^{238}U values based on 609 keV versus those based on 1764 keV between 82 and 44 ft.

The presence of radon is not an indication of man-made contamination; it is derived from decay of naturally occurring uranium. As a gas, radon moves easily in the subsurface, and concentrations of radon and its associated progeny can change quickly.

The plots of the repeat logs demonstrate reasonable repeatability of the HRLS and SGLS data. ^{137}Cs (662-keV) concentrations are comparable between the repeat and original HRLS log runs. Taking into account the effects of radon, the plots of the repeat logs demonstrate reasonable repeatability of the SGLS data for the man-made radionuclides and natural radionuclides at energy levels of 186, 662, 1001, 1461, 1764, and 2614 keV.

Recognizable changes in the KUT logs occurred in this borehole. A gradual increase of approximately 8 pCi/g in apparent ^{40}K concentrations occurs between 30 and 62 ft. Above 20 ft, ^{40}K concentrations are relatively low, which indicates the surface seal of grout around the borehole reported by Ledgerwood (1993). ^{232}Th concentrations increase by 0.5 pCi/g at 19 ft. The increase in ^{40}K and ^{232}Th concentrations at 37 ft may correspond with the silt layer identified at 37 ft in the geologist’s log (Ledgerwood 1993).

Comparison log plots of data collected in 1991 by Westinghouse Hanford Company and in 2003 by Stoller are included. The 1991 concentration data for ^{137}Cs are decayed to the date of the HRLS logging event in June 2003 and shifted from a ground level reference to a TOC reference. The RLS tool saturated in the interval from 21 to 27 ft. On the 2003 logs, the apparent ^{137}Cs concentrations are as predicted by decay alone when compared to the 1991 log except for the depths of 138, 148, 164, and 166 ft. The report written at the time of the 1991 RLS logging event reported that no man-made radionuclides were detected below 80 ft. Comparing the two logging events, the $^{235/238}U$ concentrations based on the RLS appear slightly higher than the SGLS.

Because of the presence of $^{235/238}U$ in the vadose zone, it is recommended that this borehole be logged periodically to verify that changes in $^{235/238}U$ concentrations are not occurring. The interval from ground surface to total depth should be logged again in 5 years.

References:

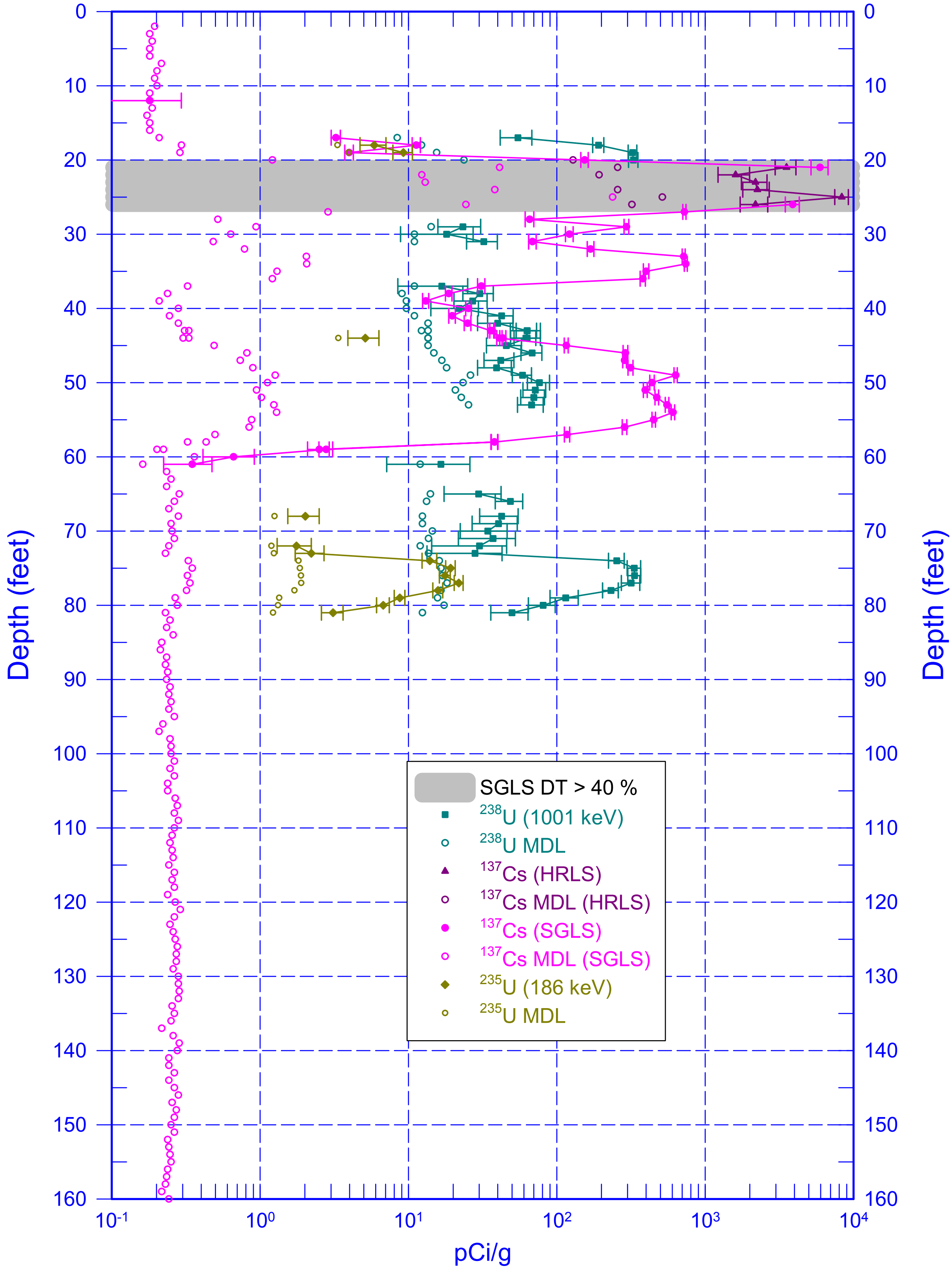
Ledgerwood, R.K., 1993. *Summaries of Well Construction Data and Field Observations for Existing 200-West Resource Protection Wells*, WHC-SD-ER-TI-005, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

---

[1] GWL – groundwater level
[2] TOC – top of casing
[3] HWIS – Hanford Well Information System
[4] N/A – not applicable

299-W22-75 (A7879)

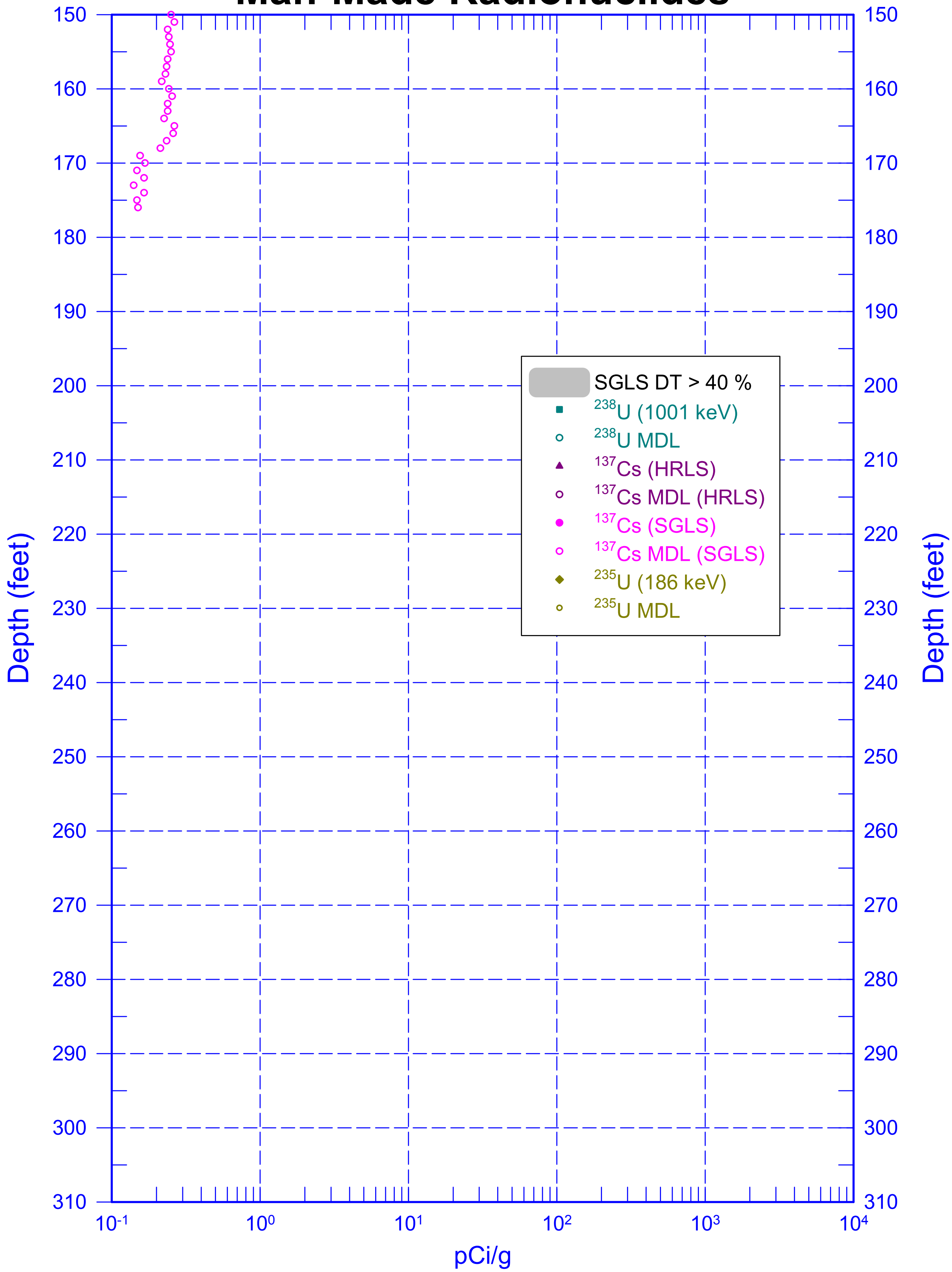
Man-Made Radionuclides



Zero Reference = Top of Casing

Date of Last Logging Run
6/03/2003

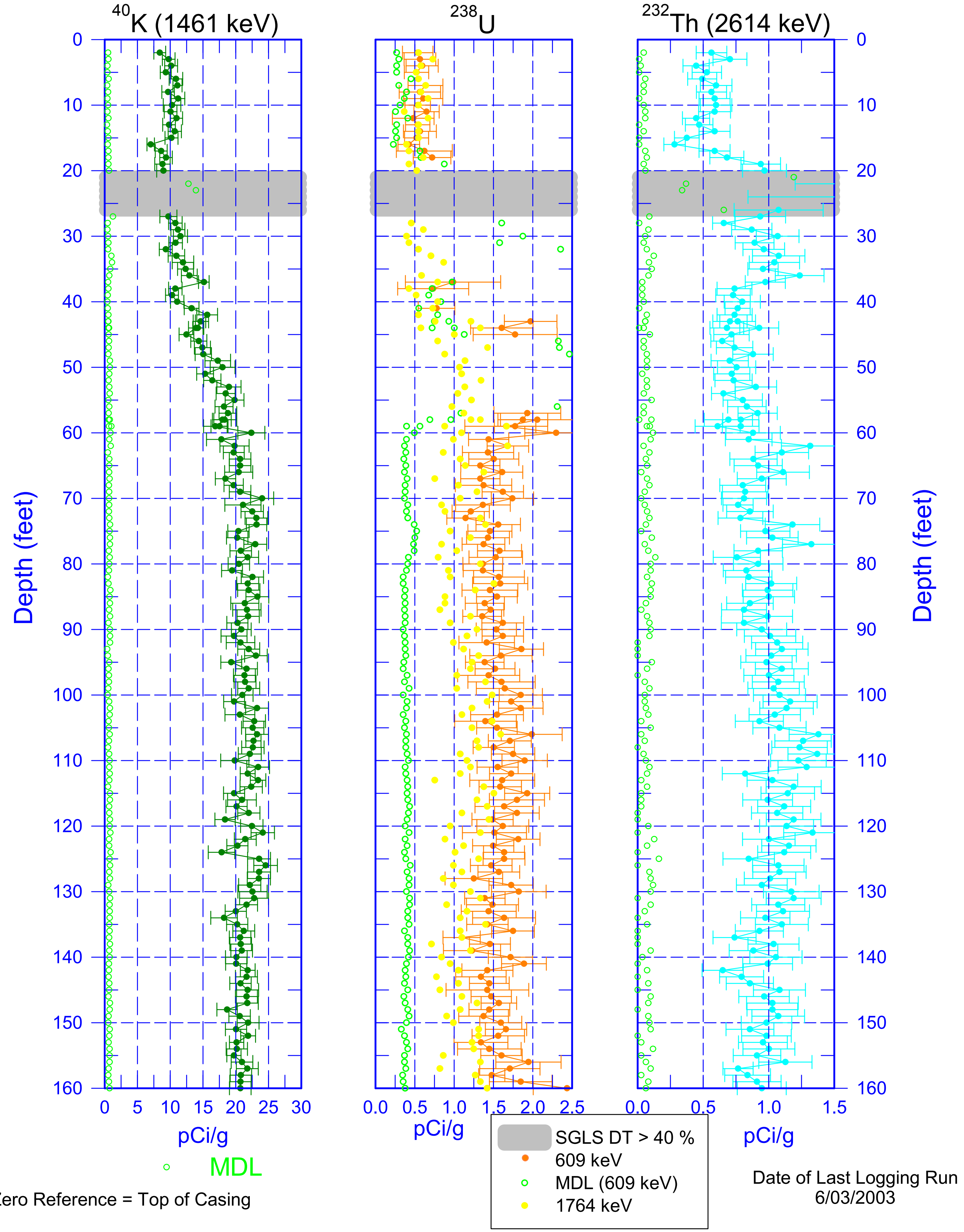
299-W22-75 (A7879)
Man-Made Radionuclides



Zero Reference = Top of Casing

Date of Last Logging Run
6/03/2003

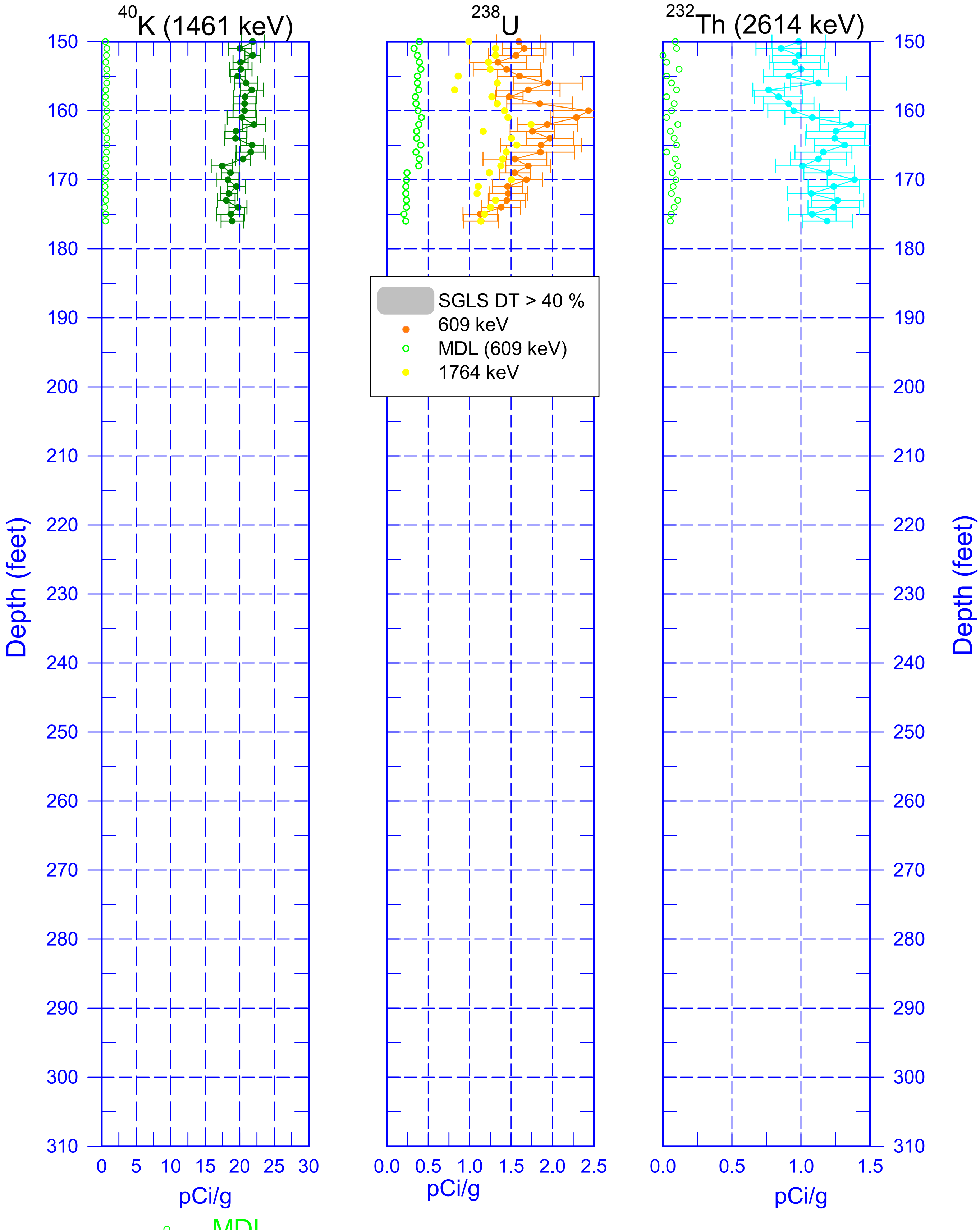
299-W22-75 (A7879)
Natural Gamma Logs



Zero Reference = Top of Casing

Date of Last Logging Run
6/03/2003

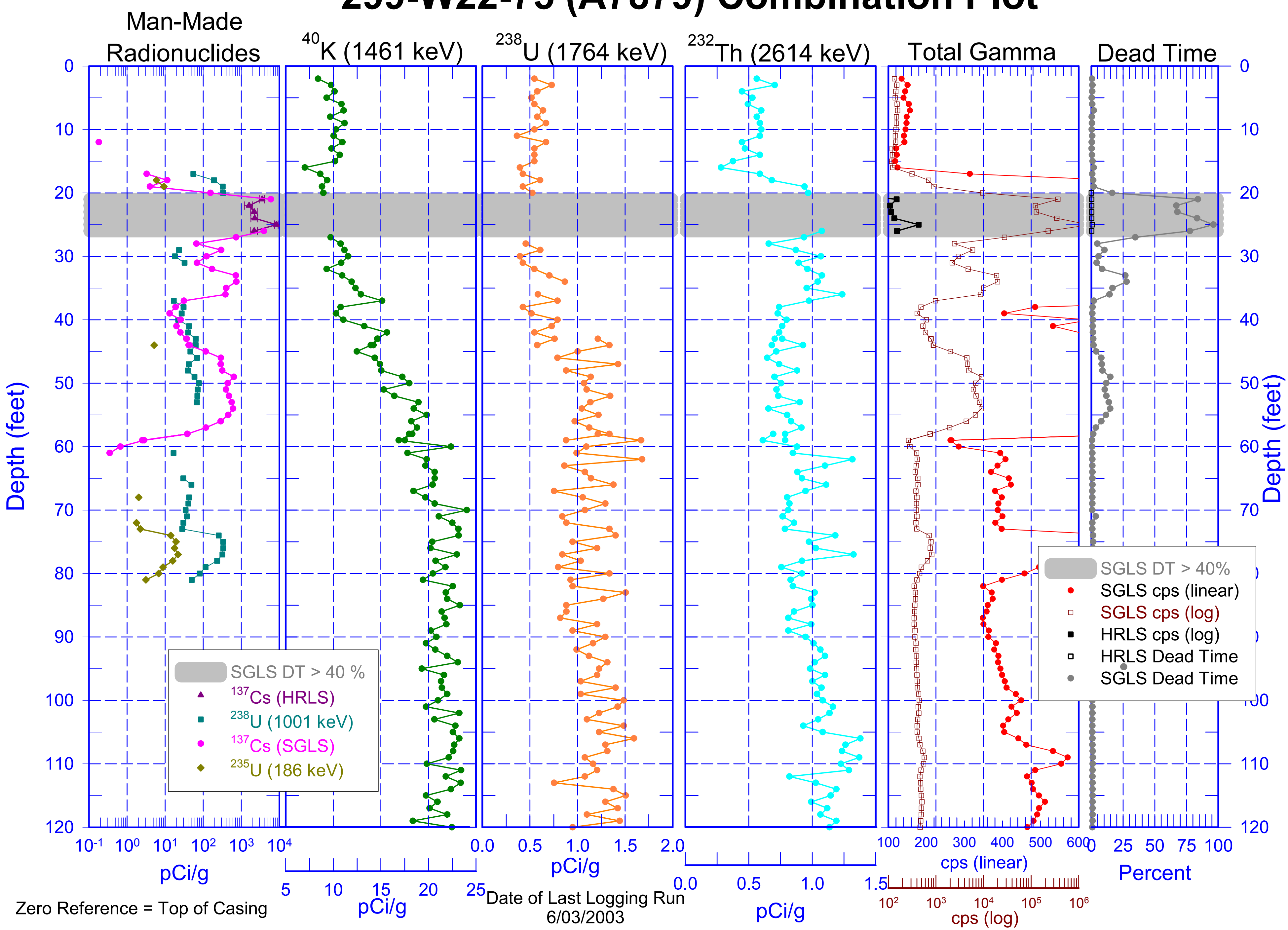
299-W22-75 (A7879)
Natural Gamma Logs



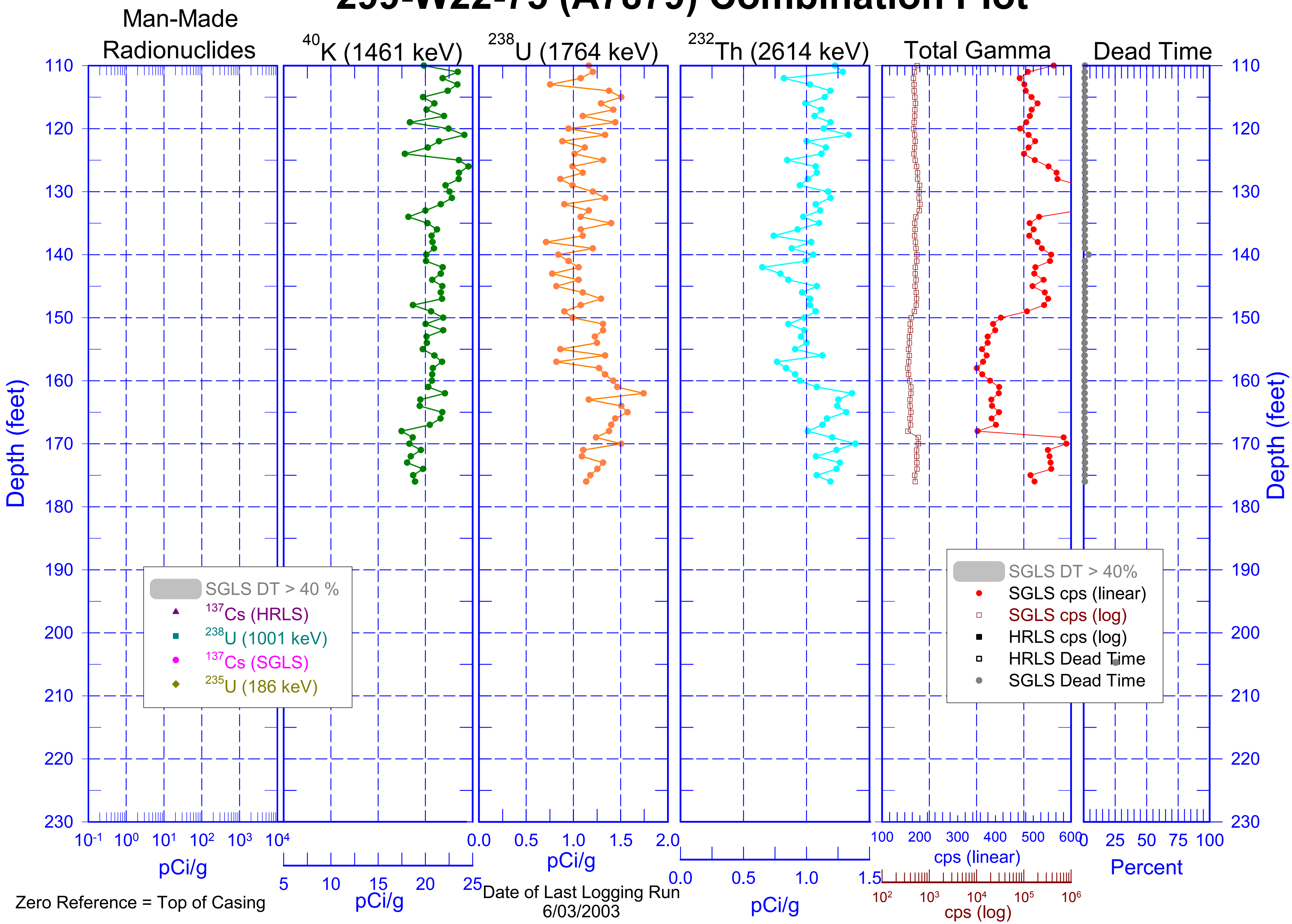
Zero Reference = Top of Casing

Date of Last Logging Run
6/03/2003

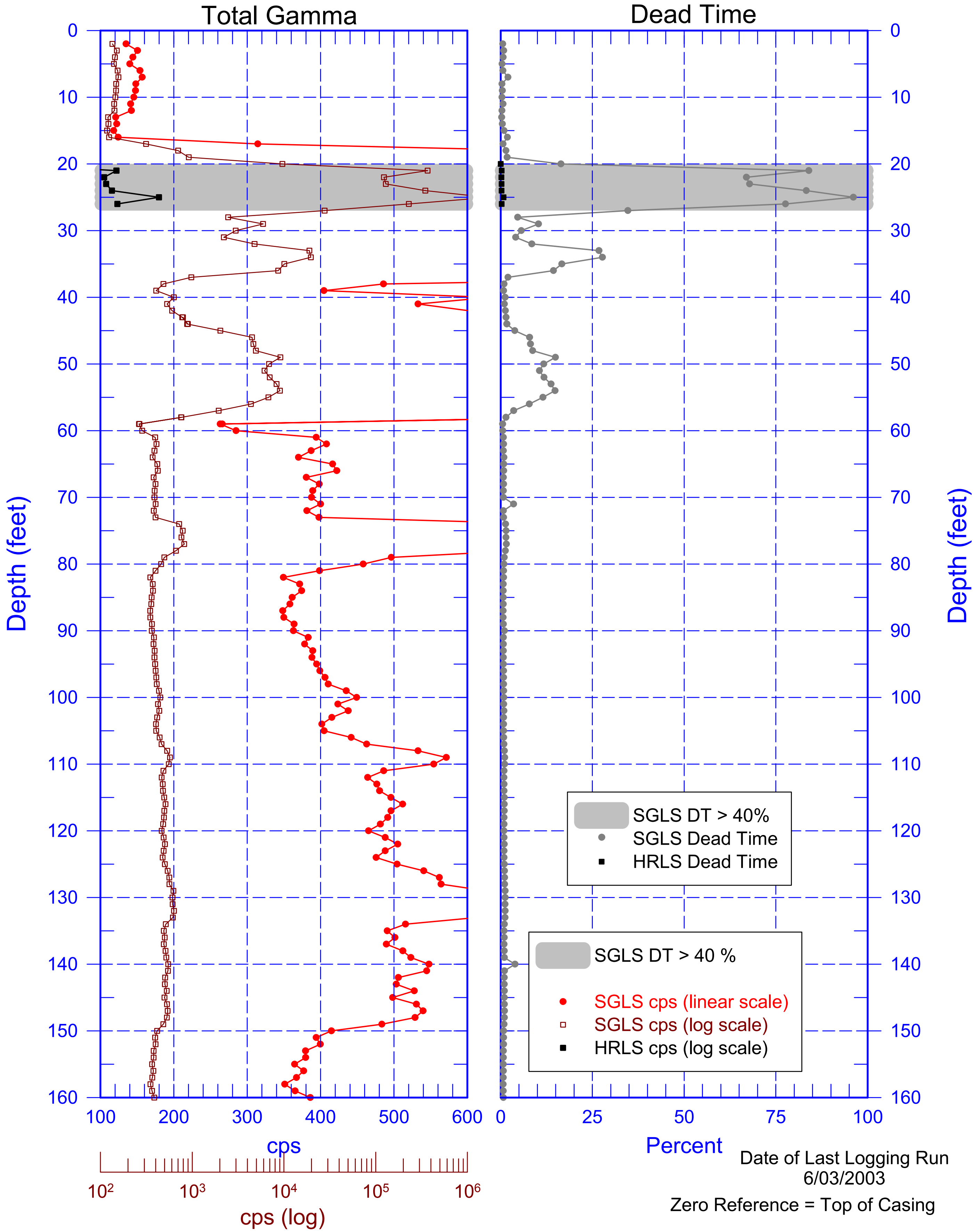
299-W22-75 (A7879) Combination Plot



299-W22-75 (A7879) Combination Plot



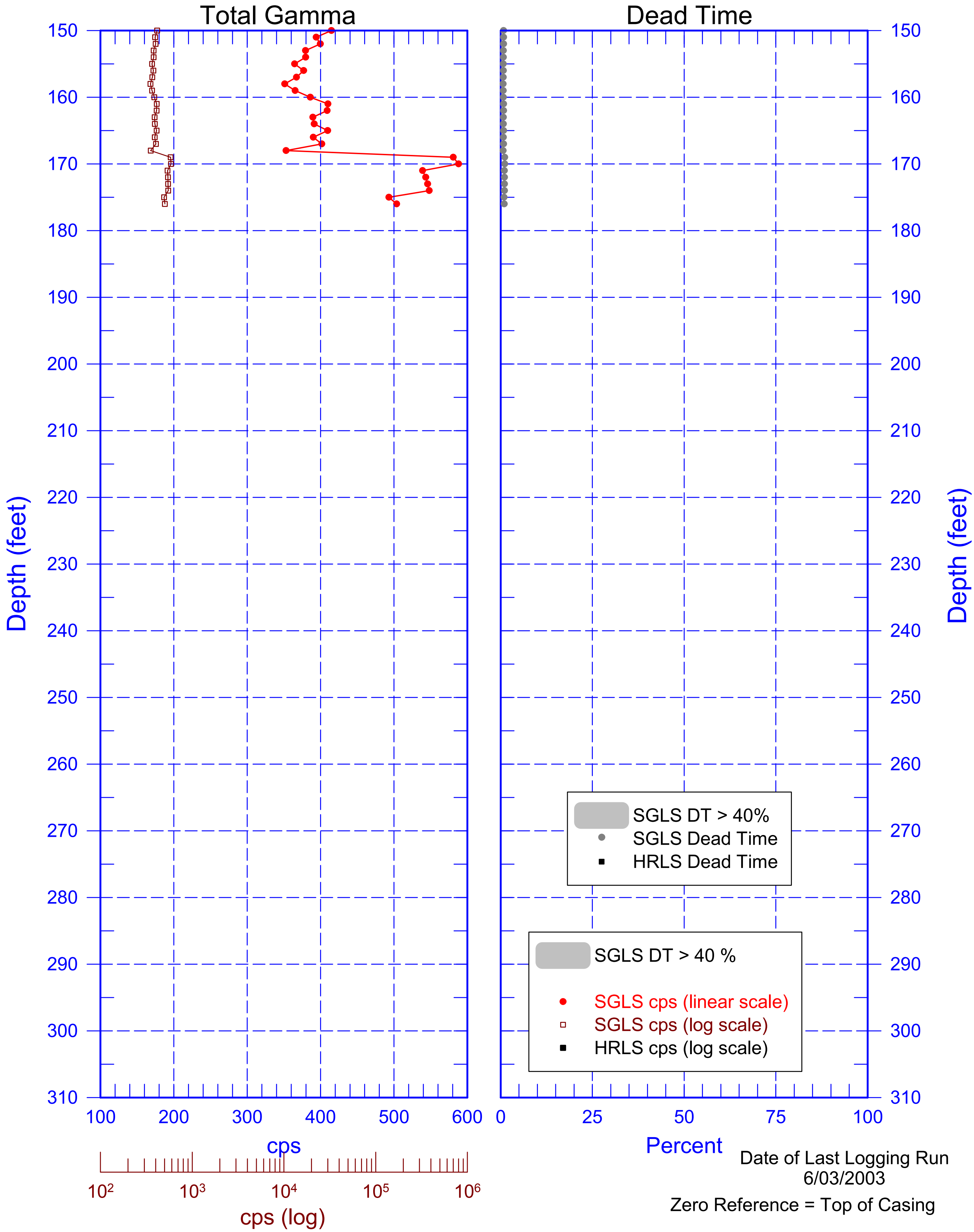
299-W22-75 (A7879)
Total Gamma & Dead Time



Date of Last Logging Run
6/03/2003

Zero Reference = Top of Casing

299-W22-75 (A7879)
Total Gamma & Dead Time

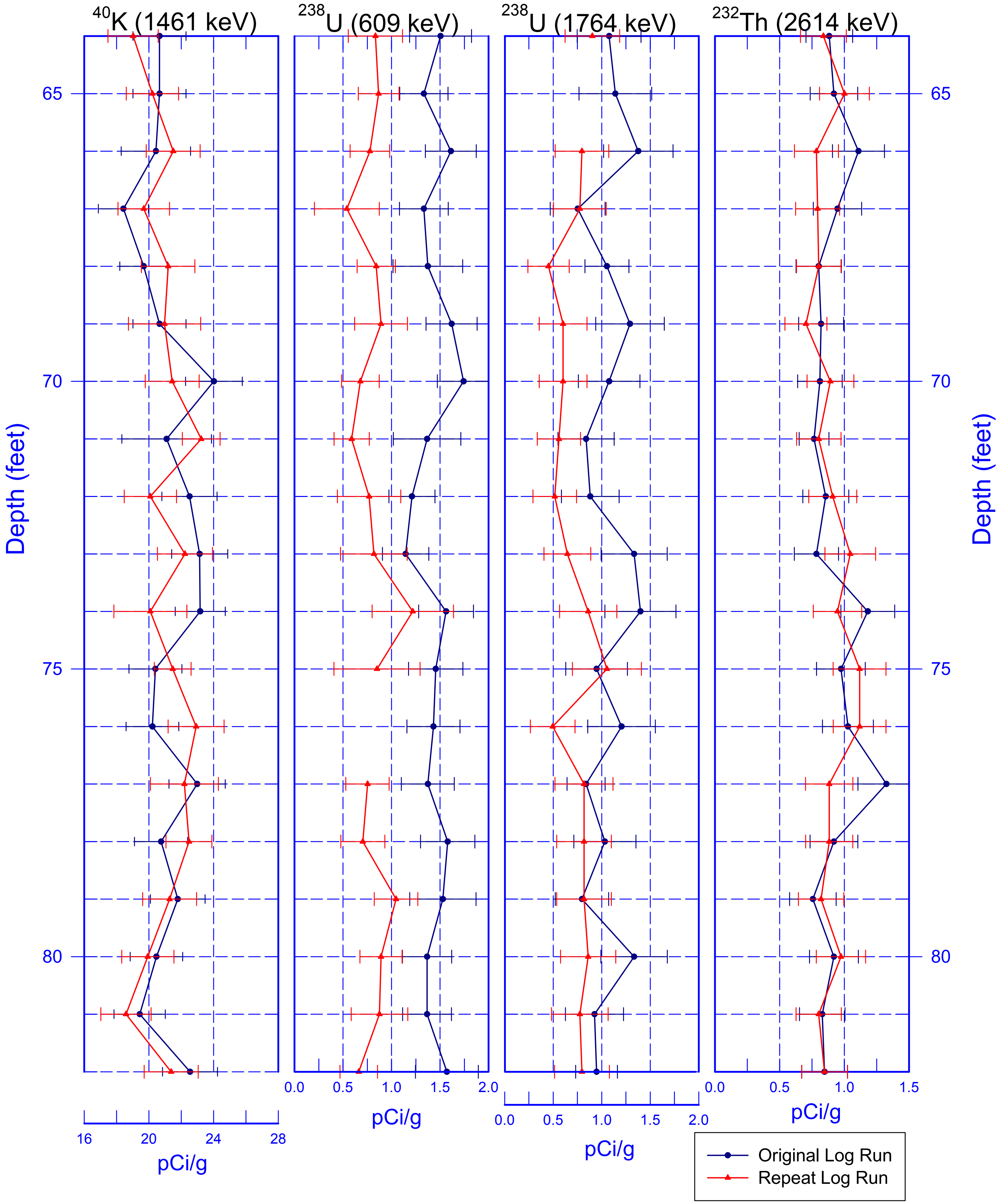


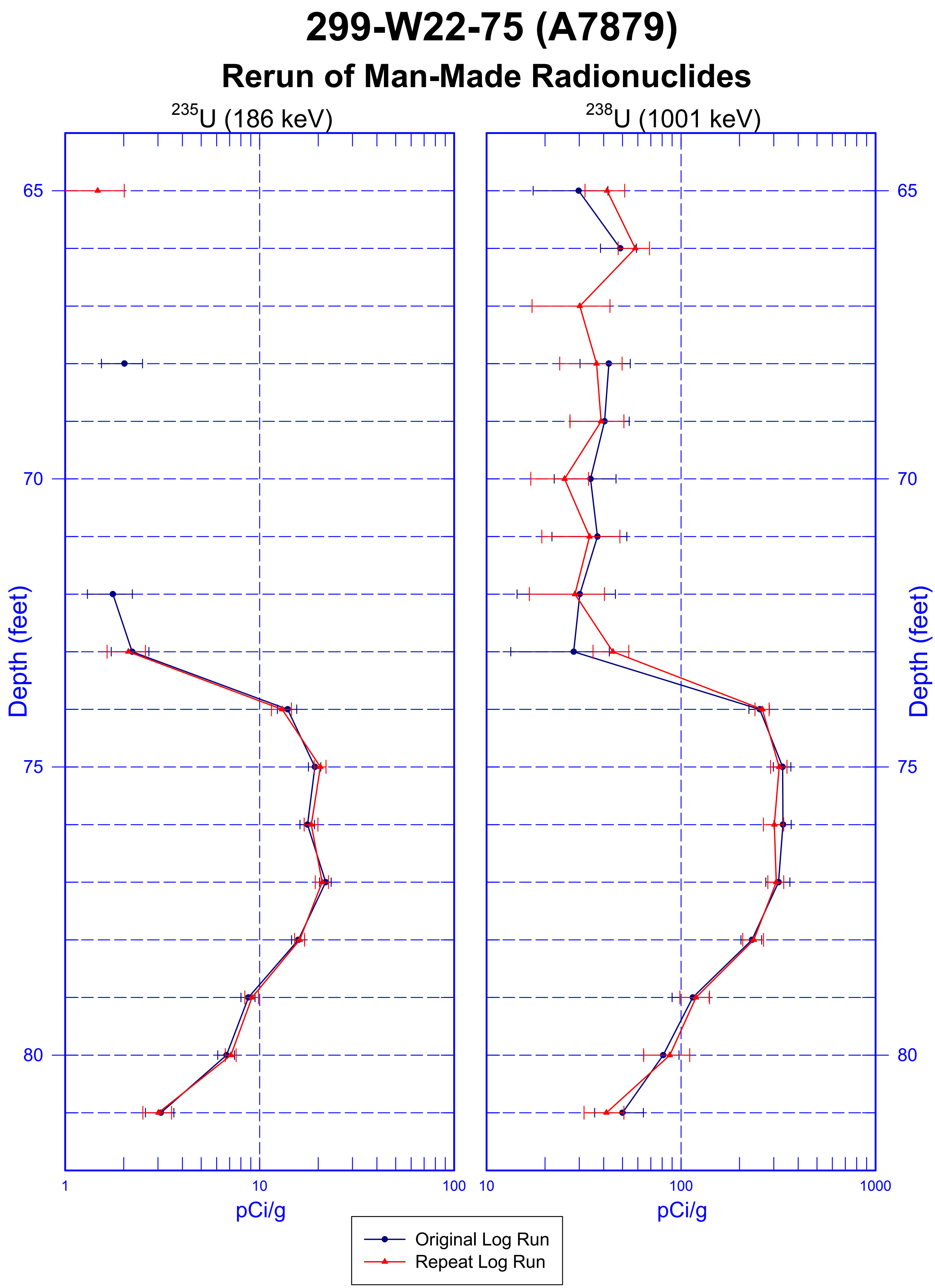
Date of Last Logging Run
6/03/2003

Zero Reference = Top of Casing

299-W22-75 (A7879)

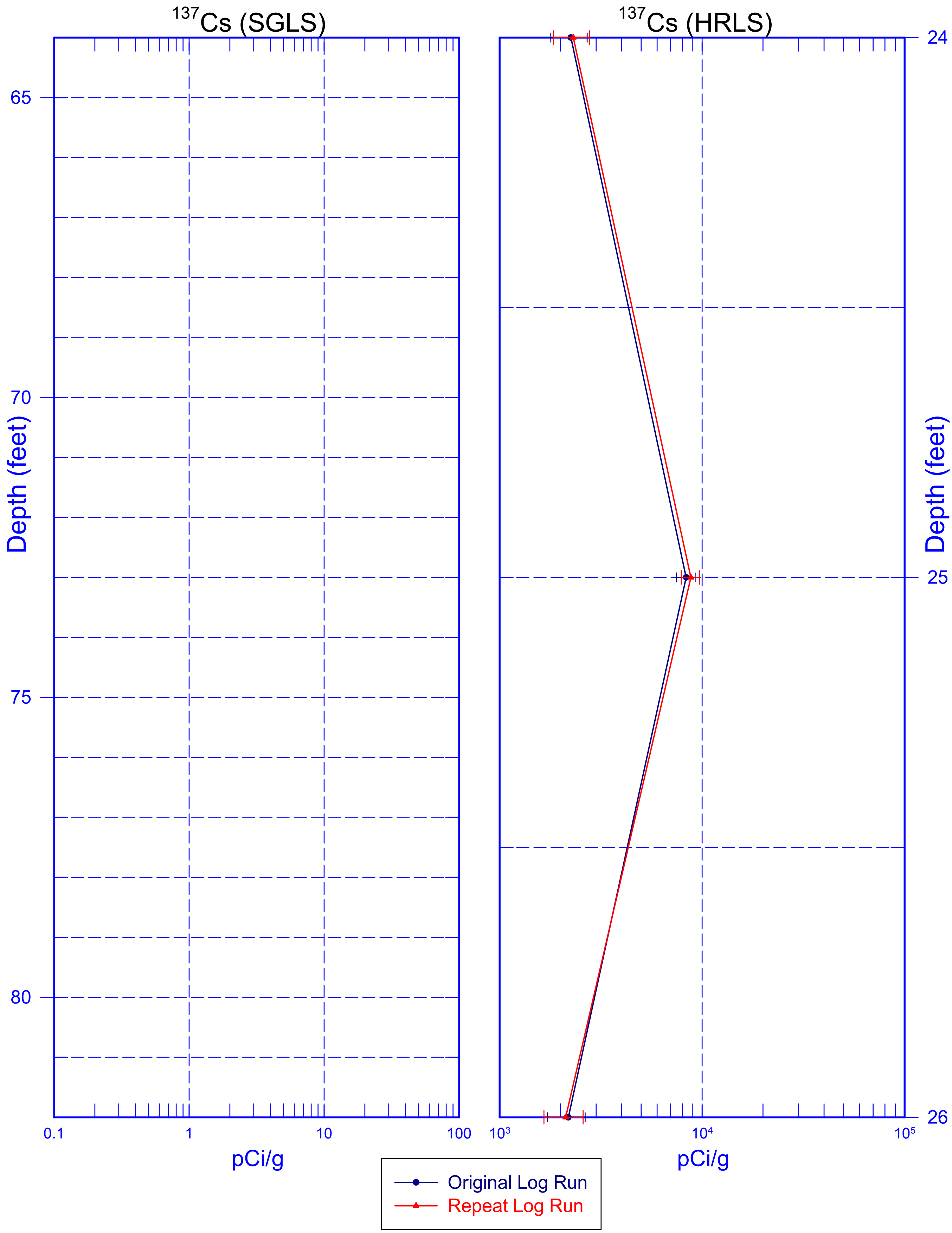
Rerun of Natural Gamma Logs (82.0 to 64.0 ft)





299-W22-75 (A7879)
Rerun of Man-Made Radionuclides
^{235}U (186 keV)
^{238}U (1001 keV)
Depth (feet)
65
70
75
80
1
10
100
1000
pCi/g
Original Log Run
Repeat Log Run

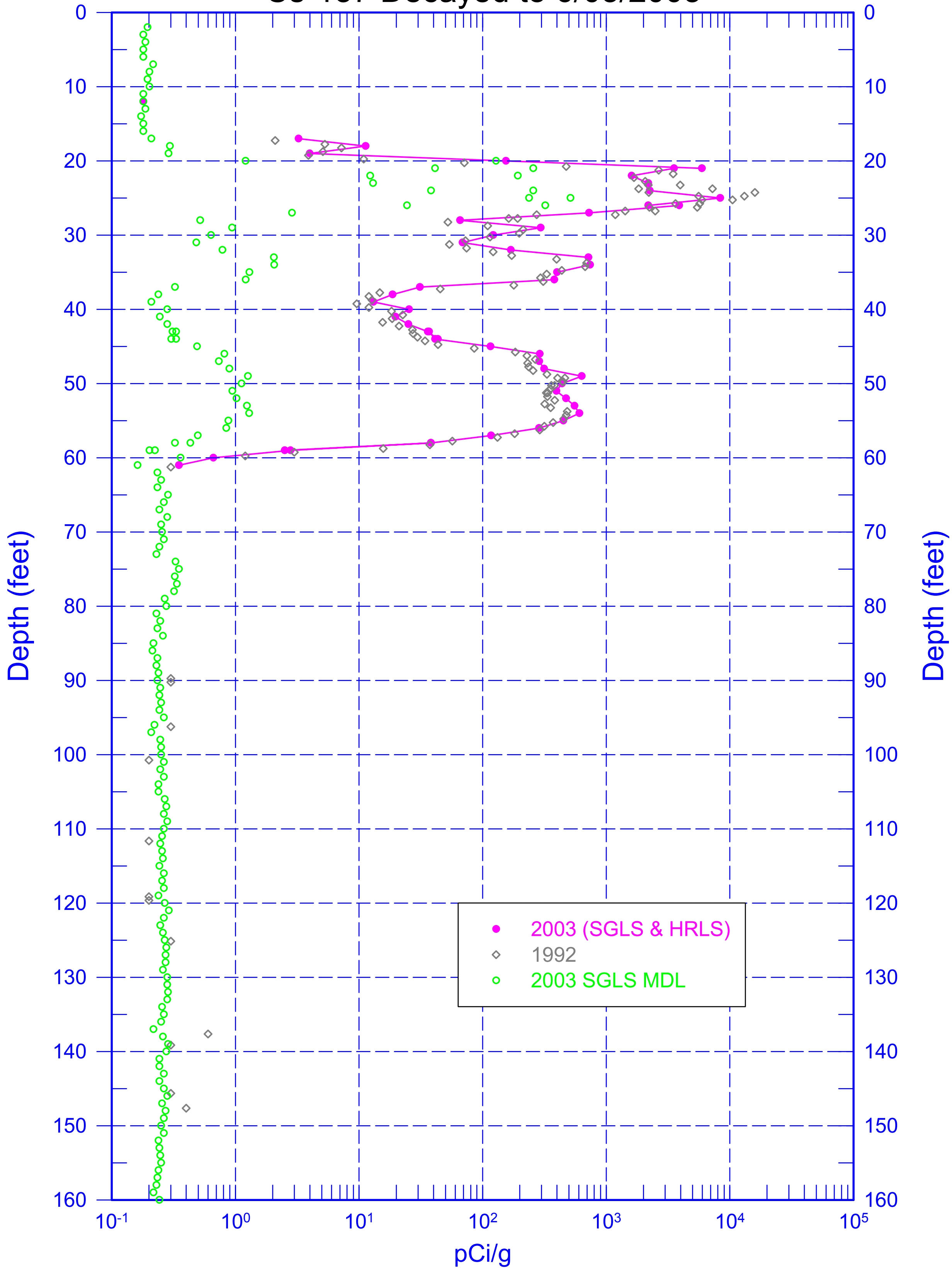
299-W22-75 (A7879)
Rerun of ^{137}Cs



299-W22-75 (A7879)

RLS Data Compared to SGLS Data

Cs-137 Decayed to 6/03/2003



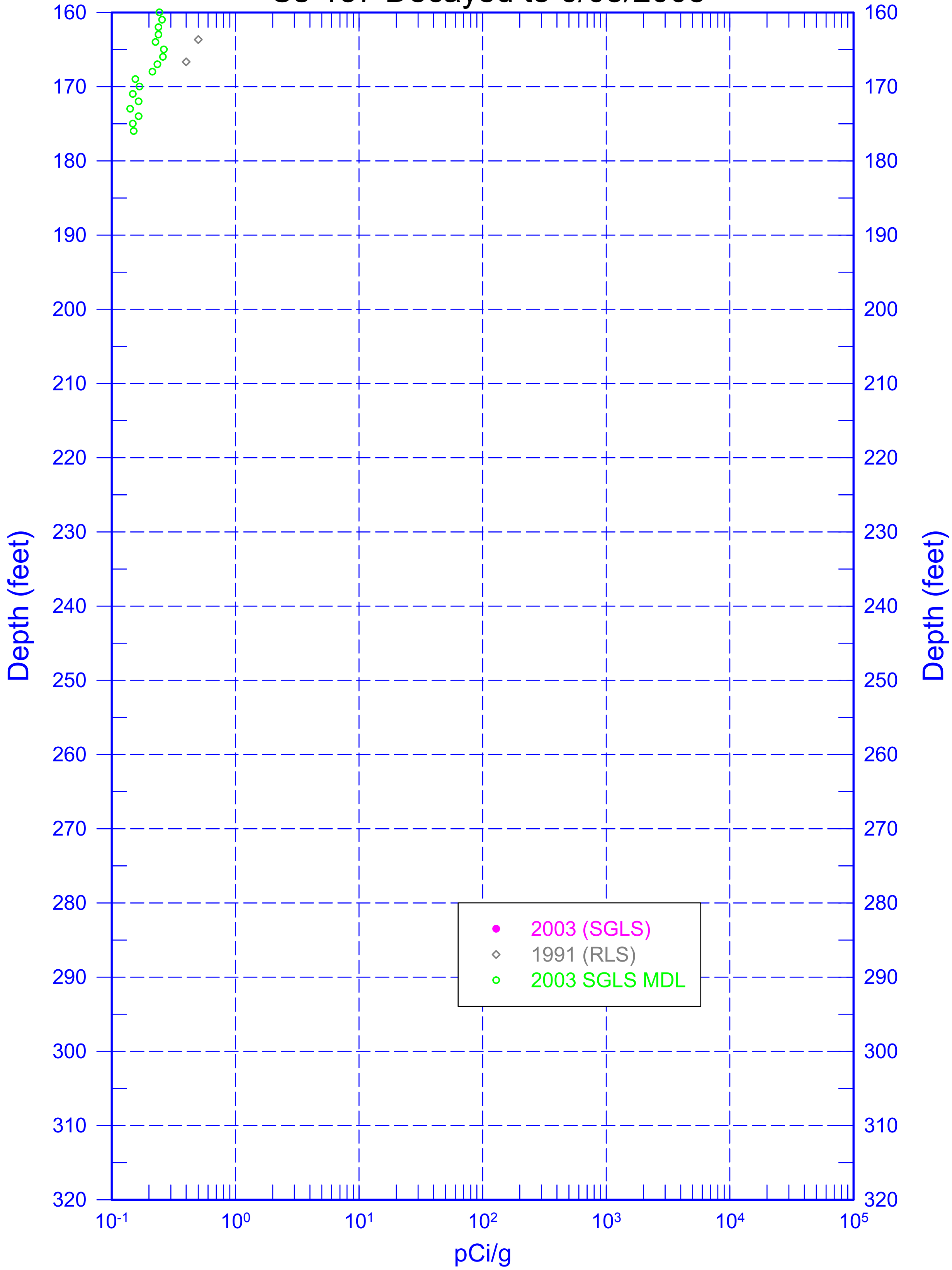
Zero Reference = Top of Casing (2003 SGLS)

1991 RLS shifted +1.25 ft to agree with SGLS

299-W22-75 (A7879)

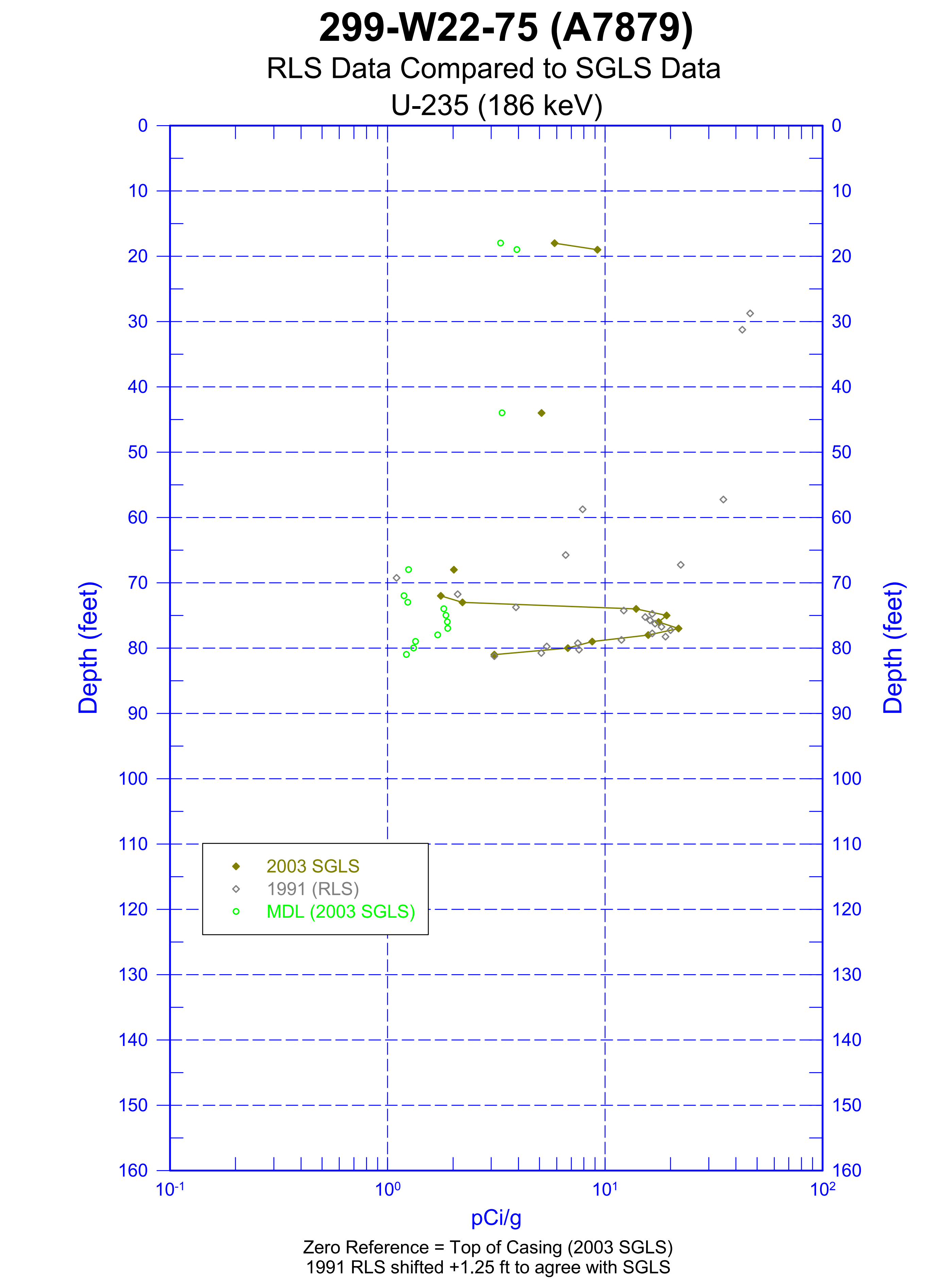
RLS Data Compared to SGLS Data

Cs-137 Decayed to 6/03/2003



Zero Reference = Top of Casing (2003 SGLS)

1991 RLS shifted +1.25 ft to agree with SGLS

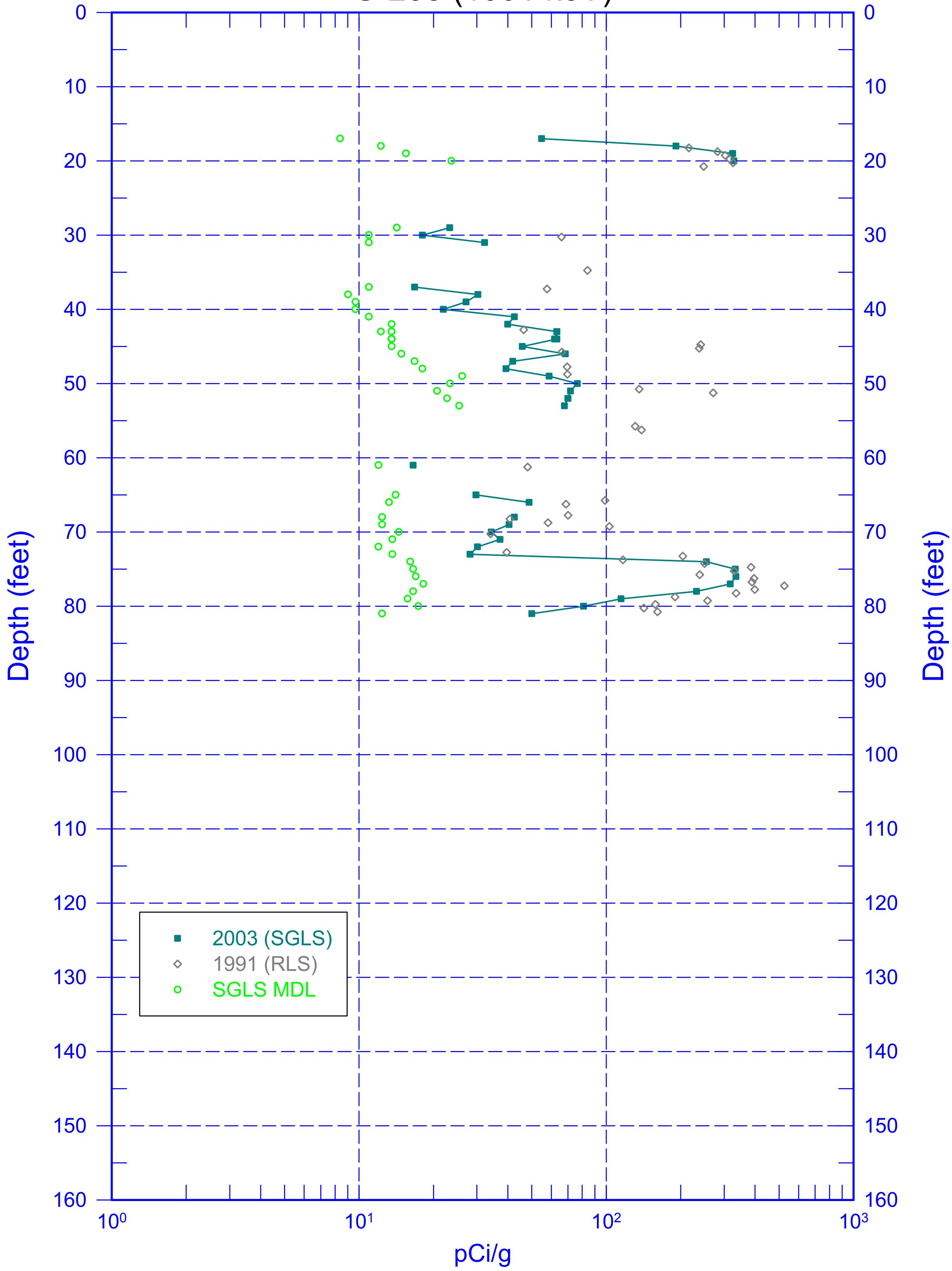


299-W22-75 (A7879)
RLS Data Compared to SGLS Data
U-235 (186 keV)
Depth (feet)
pCi/g
2003 SGLS
1991 (RLS)
MDL (2003 SGLS)
Zero Reference = Top of Casing (2003 SGLS)
1991 RLS shifted +1.25 ft to agree with SGLS

299-W22-75 (A7879)

RLS Data Compared to SGLS Data

U-238 (1001 keV)



Zero Reference = Top of Casing (2003 SGLS)

1991 RLS shifted +1.25 ft to agree with SGLS